

Central Intelligence Agency



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DIRECTORATE OF INTELLIGENCE

08 JUL 1986

MEMORANDUM FOR: Ronald K. Lohrding
Assistant Director for Industrial and
International Scientific Laboratories

FROM: [REDACTED] 25X1
Chief, Strategic Resources Division, OGI

SUBJECT: A Technical Assessment of Panama's
Petroleum Potential [REDACTED] 25X1

This report is the third in a series of CIA country assessments examining the oil potential of Central America. The first report, on Guatemala, indicated that potential oil reserves in that country could be around 500 million barrels--roughly a fifty year supply at present rates of consumption. We concluded, however, that barring a huge increase in world oil prices and additional incentives to attract foreign oil companies, the chances are slim that Guatemala will exploit much of this potential. In the second report, on El Salvador, we concluded that the possibility for any significant accumulation of petroleum is so small that it can be considered zero. The attached report is intended for a technical readership. We suggest that the non-technical audience read the Summary and Background on pages 1-3 and skip to the Energy Balance and Outlook section on page 8. If we can be of any further assistance to you on this or any related matter, please call

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Attachment:

A Technical Assessment of Panama's Petroleum Potential [REDACTED]
GI M 86-20151, March 1986, [REDACTED]

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SUBJECT: A Technical Assessment of Panama's Petroleum
Potential [REDACTED]

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OGI/SRD/PRB/gmf, [REDACTED] (1 July 1986)

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DIRECTORATE OF INTELLIGENCE

24 June 1986

A Technical Assessment of Panama's Petroleum PotentialSummary

No commercial quantities of hydrocarbons have yet been found in Panama. Although 35 wells have been drilled in the country since 1925, the geology of Panama outside the Canal Zone is largely unknown except for the general structure. Four distinct sedimentary basins lie in Panama, two of which could contain hydrocarbon accumulations. Our geological analysis indicates that these two basins may hold 225 million barrels of potential reserves--an amount nominally equal to over a 20 year supply at Panama's current level of consumption. The prospects for commercial production, however, or even exploration alone, are very slim due to the complete lack of infrastructure in promising regions, extremely difficult terrain, and the currently weak market. Any organized exploration effort in Panama, which has only one small domestic oil company, will have to be conducted with foreign assistance. This calls for improvement of concession terms, especially in today's market. [redacted]

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Panama currently consumes 27,000 barrels per day, an amount which supplies about 60 percent of the country's domestic energy needs. This level is likely to increase as a result of lower oil prices and the difficulty Panama will probably encounter in efforts to develop non-oil fuel sources. Although Panama's oil import bill has declined since 1980, mainly reflecting lower world oil prices and some domestic conservation, outlays in 1985 still amounted to \$250 million--18 percent of Panama's total import bill. [redacted]

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This memorandum was prepared by [redacted], Petroleum Resources Branch, with a contribution from [redacted] Petroleum Resources Branch, Office of Global Issues. The information contained herein is updated to 24 June 1986. Comments may be directed to [redacted] Chief, Strategic Resources Division, [redacted]

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A Technical Assessment of Panama's Petroleum Potential

Background

Panama is basically unexplored. Even in areas where drilling has indicated the possible presence of oil or gas, no thorough exploration effort has ever been undertaken. Geophysical prospecting has been sparse onshore and almost nonexistent offshore. In the Darien Basin, Panama's most promising region for petroleum occurrence, the majority of prospective structures have never been drilled. Moreover, of the 35 wells drilled in Panama since 1925, only 13 have been drilled to depths greater than 4000 feet. Based on our understanding of the regional geology of Central America, deeper drilling would be required to delineate commercial oil accumulations in Panama. We believe that exploration in Panama has been far too limited to draw definite negative conclusions about the country's petroleum potential. Indeed, some drilling results provide the basis for mild optimism. Of the 25 wells drilled in basins with favorable geology, seven had oil or gas shows.¹ Of the three wells drilled in the virgin offshore areas, two had gas shows. [REDACTED]

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Although no foreign oil companies are currently active in Panama, some oil industry specialists believe that certain geologic structures in Panama may be extensions of producing areas in Colombia and other parts of northwestern South America. Recently, for example, Universal Drilling, Universal Exploration, and Transworld Exploration applied for drilling concessions on the Pacific side of western Panama. Another American oil company, Oxoco, hopes to drill an exploratory well offshore in the Gulf of San Miguel, an area near promising hydrocarbon shows. We do not know if the recent sharp drop in world oil prices has caused these firms to reconsider their plans. But as long as prices remain weak, foreign companies will be very reluctant to make any substantial financial commitment in risky areas like Panama. [REDACTED]

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¹A "show" (oil or gas) is the occurrence of hydrocarbons, but usually in trace amounts. Wells with shows are considered dry because of the small amounts of hydrocarbons involved. Nevertheless, a show indicates that some hydrocarbon generation has taken place in the area, and therefore that nearby structures may contain larger accumulations. [REDACTED]

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GI M 86-20151 [REDACTED]

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Petroleum Potential

Our geological analysis indicates that Panama may have potential petroleum reserves of 225 million barrels. To put this estimate in a Central American perspective, Panama's potential reserves represent:

- o About one-half of our estimated potential reserves in Guatemala;
- o About equal to the low end of our present estimate of potential reserves in Honduras;
- o More than a 20 year supply at the current rate of consumption. [REDACTED]

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Our analysis also indicates that about 80 percent of Panama's potential reserves are probably in the Darien Basin, adjacent to Colombia. The remainder are probably in the Bocas del Toro Basin located near the border with Costa Rica (see map). The methodology used to develop these estimates is given in the appendix. [REDACTED]

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Geology of Panama

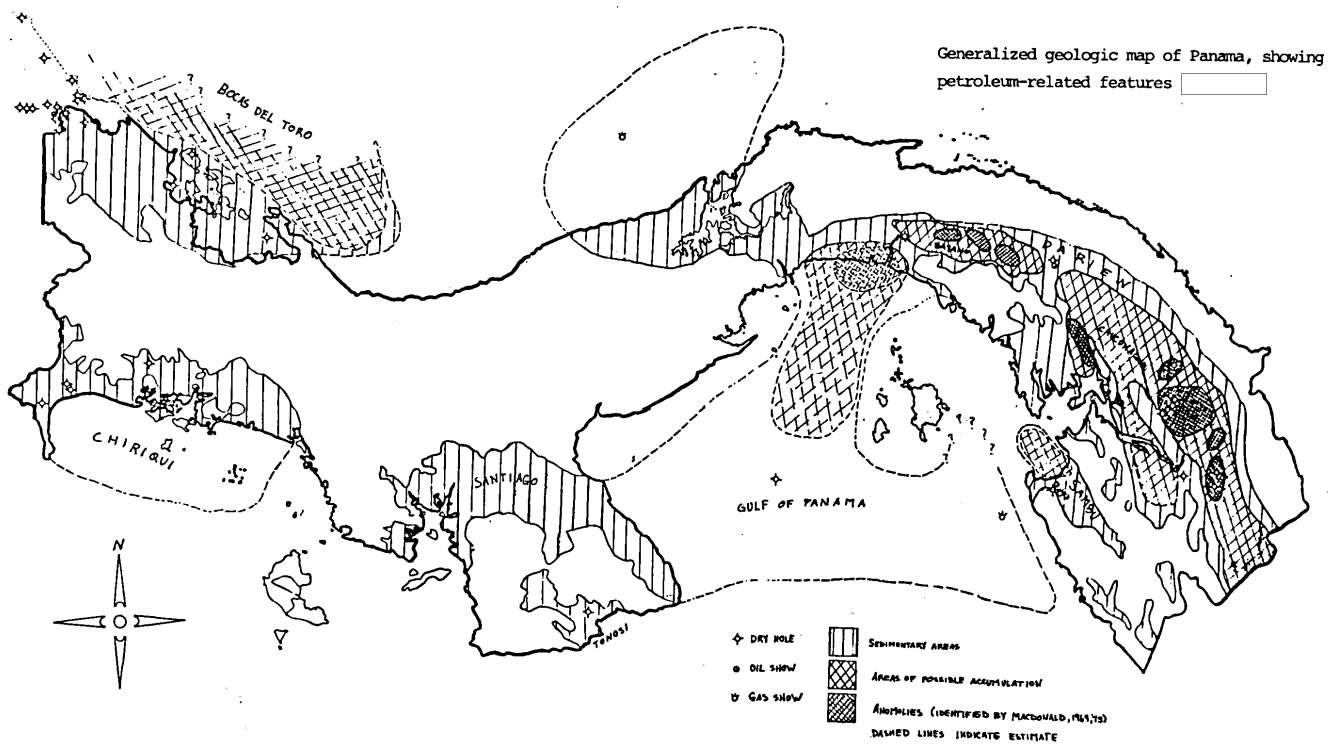
Panama can be divided geologically and structurally into two provinces, lying east and west of the Canal Zone. West of the Canal Zone the mountains of the Central Range, an extension of the Cordillera de Talamanca of Costa Rica, form an axis that runs from Costa Rica to the Canal Zone. These mountains consist of early Tertiary through Miocene and even Recent age volcanics and volcaniclastic sediments that were uplifted on a block of oceanic basement rock. On either side of the Central Range lie sedimentary basins. The Bocas del Toro Basin to the north extends into Costa Rica as the Limon Basin. The Chiriqui Basin, to the south of the Central Range, is bounded on the southern side by the remnants of a mountain range made up of the Cretaceous-age Basic Igneous Complex, which some geologists believe is an extension of the western Andes in Columbia and the Nicoya Complex of Costa Rica.² [REDACTED]

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The eastern half of Panama consists of a pair of arc-shaped mountain ranges on the north and south sides of a deep synclinal basin. The Pacific ranges are composed of Cretaceous and early Tertiary volcanics. The San Blas mountains on the Caribbean coast are similar, although some evidence suggests a granitic core, which may have contributed clean-sand sediments throughout the drainage area. Nevertheless, most Tertiary sediments were

²Weyl, R., Geology of Central America, 1980, Gebruder-Borntraeger, Berlin [REDACTED]

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derived from quartz-poor basic igneous rocks and are also somewhat tuffaceous, conditions which reduce porosity and permeability in potential reservoirs and increase impurities in any petroleum generated. []

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Between the Pacific and Caribbean mountain ranges lies the synclinal Darien Basin. The basement in eastern Panama is probably an upthrown block of oceanic crust. The major structural elements of eastern Panama are northwest trending faults, along which wrench-induced folds have formed. Additional fracturing takes the form of a polygonal series of minor faults, reflecting the complex stress patterns of this extraordinary tectonic region.³ Gravimetric data indicate only three sedimentary areas in eastern Panama: the Darien Basin, the Gulf of Panama, and an unnamed trough of low-gravity late Tertiary sediments off the Caribbean coast. []

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The isthmus lies on a subduction zone formed where the Nazca plate and the Caribbean plate meet. The morphology of this zone apparently reverses on either side of the Canal Zone, with the Caribbean Plate riding over the Nazca Plate in the west and plunging beneath it in the east. Transform faults near the Canal Zone divide these two segments. The regional tectonic setting is one of compression, as shown by strong deformation in the northwest and numerous compressional folds in the east. In the east, however, local basin-and-range type vertical movements determine basin structure. []

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Prospective Petroleum Bearing Areas

Four distinct sedimentary basins lie in the country, two of which have good potential for hydrocarbon accumulations. In addition, portions of the Gulf of Panama and the offshore Caribbean may have potential, but almost no exploratory work has been done in these areas. The Darien Basin and the Bocas del Toro Basin are Panama's most promising petroleum areas. []

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Darien Basin

The Darien Basin is a structural extension of Columbia's Atrato Basin, although more tectonically active. Like the Atrato Basin, The Darien Basin is relatively unexplored. It is a quasi-synclinal trough covering 4400 square miles, and filled with late Eocene through late Miocene-early Pliocene sediments. Predominant lithofacies are of bathyl and shallow marine origin, with occurrences of volcanoclastics that are minor by Central American standards. Abyssal radiolarian cherts are present in the lowest parts of the section, suggesting a progressively

³MacDonald, Harold C., 1969, Geologic Evaluation of Radar Imagery From Darien Province, Panama, in Modern Geology, v. 1, p.1-63 []

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shallower depositional environment during the Tertiary. This shallowing trend is complicated by Tertiary vertical movements which are indicated by unconformities in the stratigraphic column, present-day peneplanation, and evidence at high altitudes of past peneplanation. Uplifting stripped away post-Miocene sediments on many structural crests in the eastern half of the Darien Basin, and on some anticlines all Tertiary sediments have been stripped away. [REDACTED]

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The Darien Basin takes the form of several sub-basins, including the Chucunaque, Bayano, Balsa, Tuira and others. In addition, several graben basins (such as the Sambu) in the southern mountain ranges are considered part of the Darien Basin. The greatest thickness in the Darien Basin is in the Chucunaque sub-basin, where sediments are up to 6500 meters thick. The rocks here range from Eocene to early Pliocene. The Bayano sub-basin is structurally a graben, with sediments ranging in age from late Eocene to late Miocene. The Bayano sub-basin is shallower than the Chucunaque, reaching a maximum depth of about 3500 meters. Between these two major sub-basins is a platform known as the Canazas Dome. This area generated great interest at one point but has since proved a disappointment; a well drilled by Sossa Petroleum to a depth of 1200 meters yielded only an uneconomic show of oil. The most notable feature in the southern mountain ranges is the Sambu Graben, where four of the five wells drilled had either gas or oil shows. The Sambu structure probably deepens offshore in the shallow waters of the Gulf of San Miguel--an area that might be promising. Near the northern part of the Gulf of Panama the Darien Basin curves southwestward and apparently plunges gently beneath the Gulf. Potential reservoirs may exist here in the form of migrating sand bars, formed from sediments derived from silicic rocks in the San Blas mountains of the Caribbean.⁴ This scenario, based on the presence of visible sand bars near the Bayano Delta, has some merit but is largely speculative; little is known of the offshore structure of this area, and even less is known of its potential for hydrocarbon generation. [REDACTED]

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The Darien Basin is probably Panama's best hope for the discovery of hydrocarbons:

- o Rapid deposition of sediments in the basin would have inhibited the escape of any hydrocarbons being generated.
- o Good--though not ideal--reservoir quality sediments accumulated during Tertiary time as coarse detritus

⁴Wing, R., 1971, Structural Analysis From Radar Imagery of the Eastern Panamanian Isthmus--Part I, in Modern Geology, v.2, p. 1-21,--Part II, in Modern Geology, v.2, p. 75-127. [REDACTED]

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[redacted]

from the surrounding mountain ranges collected in the basin.

- o Tectonically controlled faulting and folding, notably wrench-induced en-echelon folding along the southern margin of the basin, produced many potential structural traps.
- o Restricted access to the sea resulted in an almost ideal reducing environment. Despite periodic inundations, the basin remained an essentially enclosed intermontane depocenter--similar to Venezuela's prolific Maracaibo Basin, but with more disruptive faulting, uplift and erosion.
- o The region is situated on a complex subduction zone and probably has a high geothermal gradient, which may help offset the fact that the basin on average is not particularly deep. [redacted]

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The presence of source rock in the basin is generally accepted with the Arusa shale being the most likely formation (figure 1). Because of the ubiquitous volcanically-derived sediments present in the Tertiary column throughout Panama, the quality of the source is sometimes questioned. Extensive volcanism, however, had ceased in eastern Panama by the early Tertiary, so source rocks of at least minimal quality probably exist. Reservoirs may actually be the fractured source rocks themselves, especially in the central synclinal portions of the Chucunaque sub-basin, and in the eastern half of the Bayano sub-basin. Nevertheless, the 16 wells drilled in this basin have all been dry (six had uneconomic shows of oil and gas). This may be because the uplifted and subsequently weathered crests of many anticlines (possible traps) have been stripped of reservoir rock, and because some potential reservoir formations are exposed to flushing on the north side of the basin. On the other hand, radar imagery indicates several geomorphic anomalies, suggesting possibly complete columns in some subsurface structures, most of which are still undrilled.⁵ [redacted]

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In summary, the lithology of the Darien Basin is adequate, though not ideal, for reservoirs and source rocks. While the tectonics and structure would normally be favorable, uplift and erosion may have allowed a large portion of any hydrocarbons generated to escape. [redacted]

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⁵Wing, Richard S., and MacDonald, H.C., 1973, Radar Geology-Petroleum Exploration Technique, Eastern Panama and Northwestern Columbia, in American Association of Petroleum Geologists Bull., v. 57, n. 5, p. 825-840. [redacted]

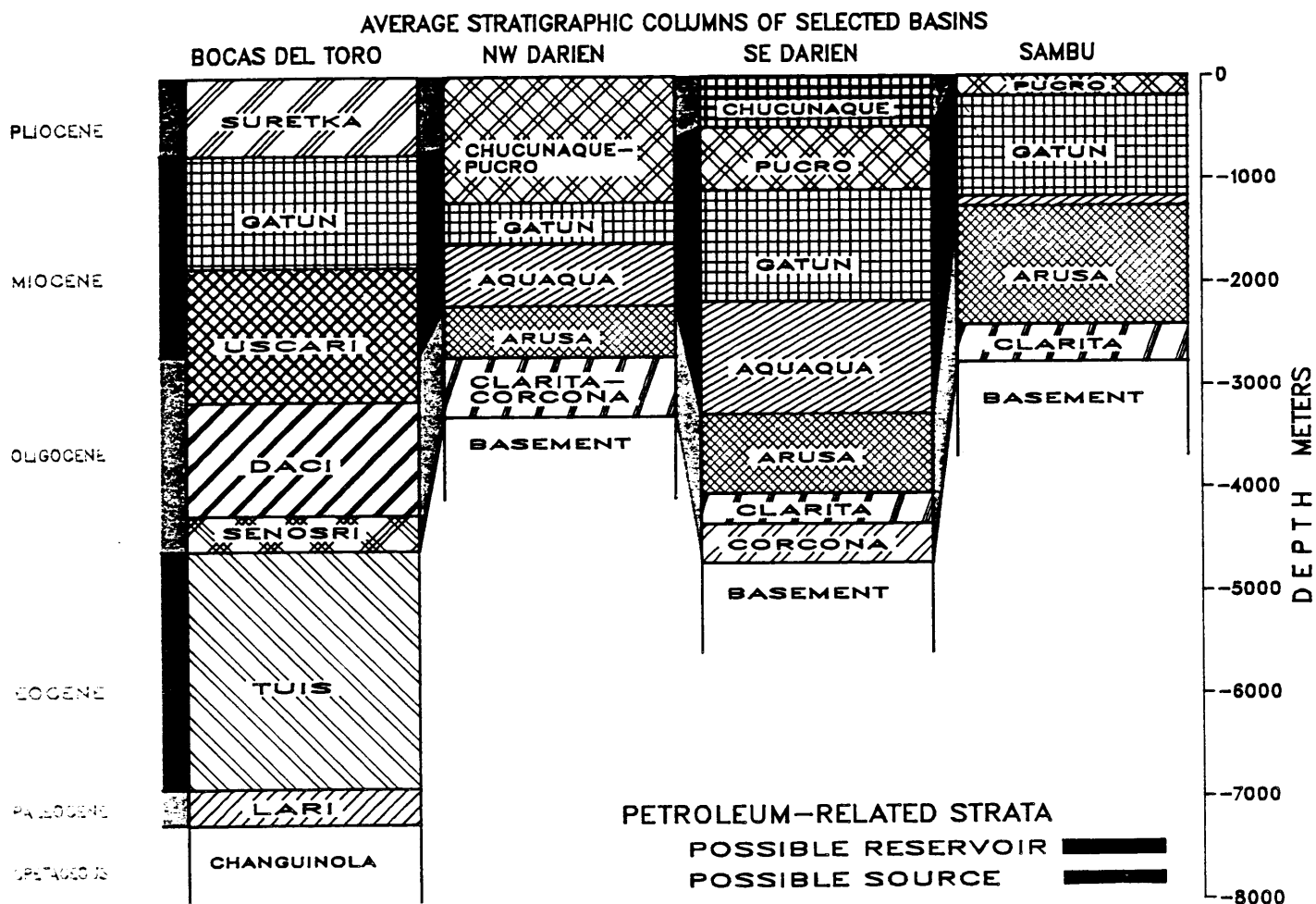
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FIGURE 1

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Bocas del Toro Basin

The Bocas del Toro Basin is an extension of Costa Rica's Limon Basin, where drilling has been disappointing except for some minor oil shows near Panama's border. On the Panama side six dry wells have been drilled (to roughly 2500 meters each), but they have all been on land, whereas half the basin lies offshore. The total section may locally attain depths of 20,000 meters, although average depth is about 9,000 - 10,000 meters. The subsurface structure, at least onshore, is very complex, with overturned anticlines, repeated sections, and thrust faulting. Some geologists believe that less deformed structure occurs offshore, where the basin deepens into the Caribbean. Rocks range in age from lower Cretaceous to Pliocene, with several unconformities. Below the middle Oligocene the content of volcanics is very high. Potential source and reservoir strata are thought to be late Oligocene through late Miocene-age beds, whose hydrocarbon-bearing quality is questionable because of exposure to the oxidizing effects of the open ocean.

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The Bocas del Toro Basin may be the only basin in Panama that attained sufficient depth for substantial generation of hydrocarbons, although detailed source rock data was not available for this report. Together, the favorable and unfavorable aspects of this basin offset each other enough to justify a modest exploratory effort.

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Offshore Areas

The subsurface geology of the wholly-offshore Gulf of Panama Basin is almost completely unknown. Estimates of its size differ, but its apparent maximum area is 4000 square miles, and the thickness of sediments is no more than 3000 meters. The basin is not strongly deformed, and the only identified structures are gentle grabens. The overall shape of the basin is wedge-like, narrowing northward with maximum thickness of 3000 meters near the Pacific shelf edge. Some minor seismic, gravimetric, and magnetic surveys have been done, and these indicate that the section probably consists of interbedded terrigenous and marine clastics. In addition, seismics indicate that some onshore volcanic flows continue offshore into the basin, and the section probably contains much volcanoclastic material. Like the adjoining Santiago and Tonosi basins onshore on the Azuero Peninsula, the Gulf of Panama Basin is considered too thin and immature to have generated hydrocarbons; in any case structures probably developed too late to prevent their escape. Although one of the two wells drilled in the Gulf had a minor show of gas, the degree of thermal maturity required for substantial generation of hydrocarbons may never have occurred. The basin is too large to ignore, but we believe it has no potential because of its thin, fairly homogenous sedimentary column, and its apparent lack of structure.

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The geology of the offshore Caribbean area is not well known. A Texaco subsidiary drilled a well in fairly deep water northwest of the canal which resulted in a gas show. Some seismic work has been done which identified a series of folds probably caused by gravity sliding. The depth and areal extent of sediments off the Caribbean coast is unknown, but the area generally lies in deep water and will be expensive to drill.

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Energy Balance and Outlook

In 1985 Panama's net imports equalled 27,000 barrels a day, 90 percent of which was supplied by Mexico and Venezuela under the terms of the San Jose Accord. Because of lower oil prices and some domestic conservation measures, Panama's net annual oil import bill fell from about \$340 million in 1980 to \$250 million in 1985. Although the reduction in outlays helps Panama's financial picture, the oil import bill still represents about 18 percent of Panama's total import bill in 1985. We believe that Panama, which has one of the more bouyant economies in Central America, will continue to benefit from lower oil prices. Indeed, every \$1 per barrel drop in the price of crude represents an annual oil import savings of \$11 million at Panama's level of imports in 1985.

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Imported oil currently supplies over half of Panama's energy requirements (figure 2), and we believe it will continue to play an important role in the country's energy picture:

- o Lower world oil prices and moderate economic growth will likely stimulate domestic demand for oil. We estimate oil demand will increase slightly to between 30,000 to 35,000 barrels per day by the early 1990s.
- o Deforestation, as in most Central American countries, continues at a rapid pace, and could threaten the fuelwood supply, which presently accounts for nearly 20 percent of Panama's primary energy supply.
- o Biomass, particularly bagasse (sugarcane residue), has little potential for increase as long as sugar prices remain depressed.
- o Weak oil prices probably will lessen the urgency of switching to alternative fuels.
- o Hydroelectric capacity could be increased, and several projects are already underway. But distribution of electricity (outside the heavily populated Canal Zone) might prove abnormally expensive in sparsely populated rural areas.

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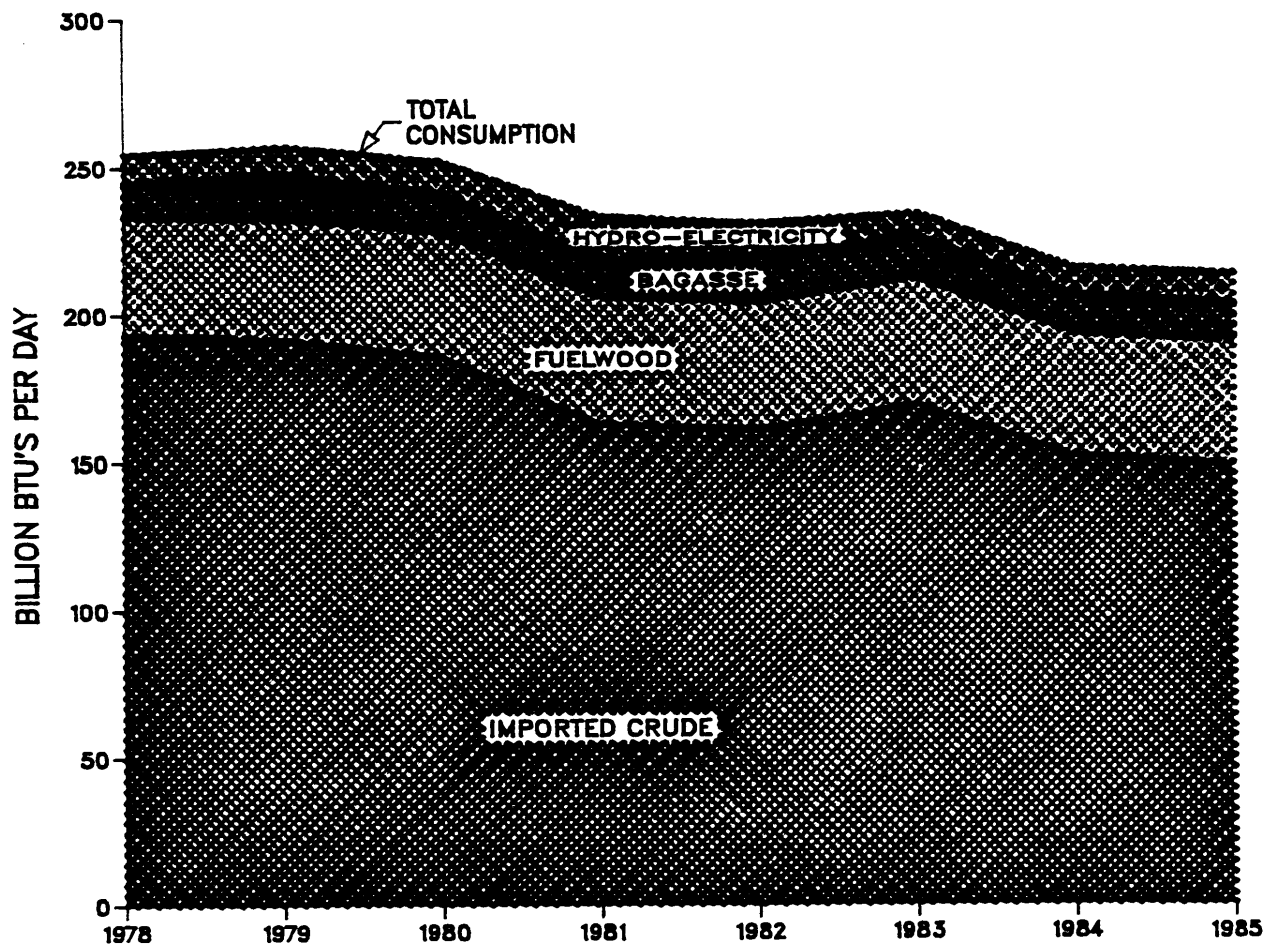
Because of the lack of technical data on possible reservoirs (thickness, depth, areal extent), and the lack of any production history, we cannot estimate how large an investment may be

FIGURE 2. DATA FOR ALL YEARS INCLUDES CANAL ZONE

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PANAMA: DOMESTIC ENERGY CONSUMPTION BY SOURCE



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necessary to develop Panama's oil potential. Given the complete lack of infrastructure (roads, pipelines, housing) in the promising regions, a large investment would be needed at a minimum. If drilling conditions approximate those in Central American countries like Guatemala--perhaps the closest analogy--operating costs could be in the \$7 to \$12 per barrel range. Because of the harsh environment in Panama's prospective regions, being either wholly offshore or covered with dense jungles and swamps, the expertise of foreign oil companies would be required to develop Panama's potential. We believe it is very unlikely that any foreign firms will commit resources to explore in Panama as long as the current market remains weak. [redacted]

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Appendix 1
Methodology

We calculated hydrocarbon reserves for each of the two prospective basins (Darien and Bocas del Toro) based on geologic analogy and a modified method of source rock potential. A great many assumptions were necessary due to the paucity of data, and it was necessary to use average values or ranges of values for various factors. The results therefore represent the average, weighted by qualitative considerations, of widely varying results. Geologic analogy, based on published basin classification systems, involved using the average hydrocarbon yield per unit volume of sediments in similar, better known basins. These average yields are often skewed by one or more very prolific basins, and this was taken into account.

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Regarding the source rock potential method, the geochemical processes of source rocks are enormously complicated and poorly understood. Nevertheless, certain criteria for judging source potential are generally accepted (for example, maturation, expulsion, and migration are known to be very inefficient processes, usually yielding less than 2 percent of original organic carbon in place). We applied these principles and our best estimates of kerogen quality, expulsion efficiency, and other factors, to possible source strata in the basins. A recovery factor of 30 percent of trapped hydrocarbons was assumed in both cases. Our best estimate of Panama's potential petroleum reserves is not the arithmetic mean of the results of the two methods. We felt less confidence in the first method (particularly in the case of the Bocas del Toro Basin), and the results were weighted accordingly.

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Table 1 summarizes the results of the calculations. In all cases the figures include both oil and gas (in barrels of oil equivalent). For comparative purposes, our estimate equals slightly less than half that of an estimate made by a private oil industry specialist in 1980.

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Though the range of possible reserves is large, such large ranges are not uncommon in the pre-production phase of basin evaluation. Figure 3 illustrates the chronologic progression of recovery estimates. Figure 4 summarizes the quality of data available for this report.

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Table 1

Panama: Potential Petroleum Reserves

(million barrels)

<u>Basin</u>	<u>ERH by Geologic Analogy</u>	<u>ERH by Modified Source Rock Volumetrics</u>	<u>ERH used in this report</u>
Darien	375	45	175
Bocas del Toro	200	<20	50
Total	575	65	225

ERH = Estimated Recoverable Hydrocarbons.

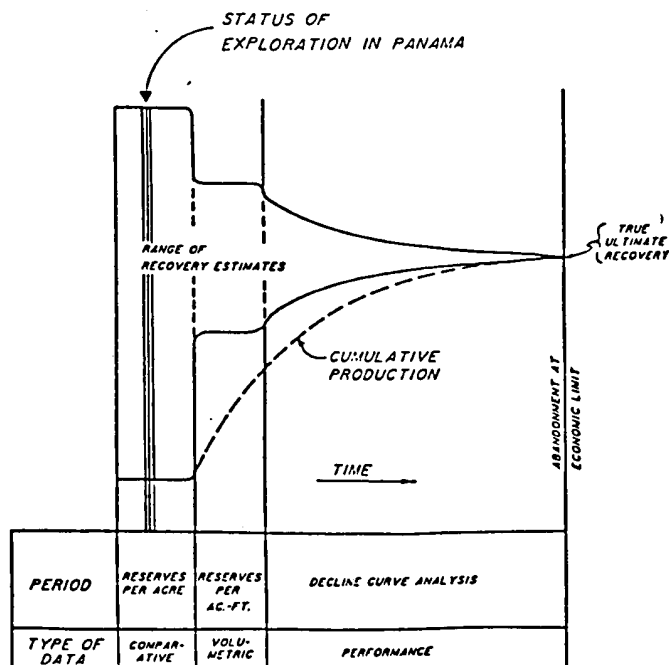
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FIGURE 3

FIGURE 4

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SCHEMATIC PRESENTATION OF THE RANGE OF RECOVERY ESTIMATES MADE DURING THREE PERIODS IN THE LIFE OF A PRODUCING PROPERTY

*INFORMATION AVAILABLE FOR THIS REPORT*

TYPE OF INFORMATION	EXCELLENT	GOOD	FAIR	POOR	NONE
PRODUCTION HISTORY					●
SEISMIC					●
WELL LOGS					●
WELL DATA				●	
GENERAL LITHOLOGY			●		
PHOTO GEOLOGY			●		
GEOLOGIC LITERATURE			●		
GRAVITY, GEOPHYSICAL				●	
RESERVOIR DATA					●
SOURCE ROCK DATA					●
STRUCTURE			●		

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